Howell v. City ofZion, et al.
Case No.: 16 CV 3949

EXHIBIT G2

CHAPTER

14

Cartridge Case Ejection and Ejection Patterns

INTRODUCTION

With automatic and semiautomatic firearms, the location of expended cartridge casings can be important in establishing the approximate location of a shooter's firearm when one or more shots have been filed. It may also be possible to determine whether a shooter moved from one location to another, or failed to move in any significant way, during the discharge of multiple shots. The value of cartridge casing locations improves if one also has an azimuth line or direction of fire for the associated shots.

Ejected cartridge casings may acquire trace evidence deposits if they strike nearby surfaces with sufficient force and the surface is of a type that generates transfer evidence. The paint on most interior walls of houses and office buildings is a good example of such evidence and can be seen in Figure 14.1. In this particular case, an altercation over a gun took place in the entrance to a residence. The red paint adhering to the mouth of the cartridge casing confirmed accounts of the gun having been discharged in close proximity to the wall.

In some instances, where the impact force is sufficient, the mouth of the ejected cartridge casing may leave a faint, crescent-shaped indentation in the struck surface. Such marks are

FIGURE 14.1 Red paint on the mouth of a 7.62 x 39rnm cariri Alge casing,

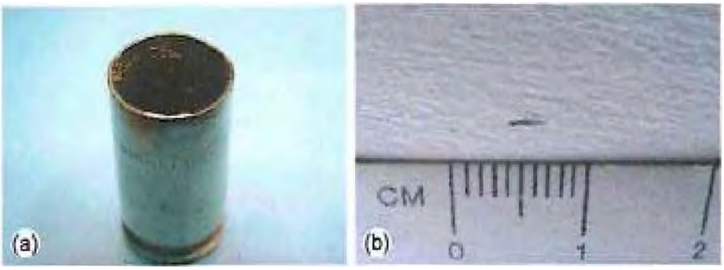


FIGURE 14,2 (a) Fired cartridge casing with adhering paint on the mouth. (b) Shallow impact mark in a painted surface from an ejected cartridge case..

(a) This 9mm cartridge case was found on the floor of a shooting scene. Only through careful handling and preservation **was** the adhering white paint presenreEL It is visible on the mouth of the cartinige at the 6 o'clock position. A corresponding crescent-shaped impact site was found many months later when we examined the scene. This mans, combined with the correspondence in color and cornposiiion of the paint and the ejection characteristics of the gun, allowed the approximate position of the shooter to be established.

(b) This crescent-shaped indentation ,just above the 0.5-cm mark) in a painted wooden surface at a shooting scene ***was*** caused by the impact of an ejected cartridge case- Given their small size, such ***marks*** can be difficult to locate and are often overlooked, hat they can be very useful in refining the shooter's position.

very subtle and no doubt go unnoticed by many scene investigators. However, conLI:tined with the ejection characteristics of the gun used, they can refine the gun's positioning.

Figures 14.2(a) and (b) show an expended cartridge casing with adhering paint on its mouth and the corresponding crescent-shaped mark impressed in the Sheetiock wall within a few feet of where the pistol was fired. From a brief study of the first photograph it should be apparent how delicate this trace evidence is and how easy it would be to lose it by care. less handling or improper packaging.

SCENE WORK-TERRAIN/SUBSTRATE CONSIDERATIONS

The issue of cartridge casing location at a shooting scene might seem straightforward. Customarily, each casing's location is entered in a suitable coordinate system followed by individual packaging in appropriate containers. Except for photographs, however, the nature of the surface on which such cartridge casings were found is seldom recorded. Examples "uncut grass, victim's front yard; yard slopes toward the street about -2 degrees"; "level asphalt parking lot with much exposed aggregate"; or "thick green shag rug in living room"

Photo-documentation and a description of the surface are needed because they are of considerable interest and importance in assessing:

- How art expanded cartridge casing came to be in a particular location. (e.g., uneven terrain, with significant elevation changes in the area of deposition, versus level terrain).
- How much additional movement, if any, the ejected cartridge casing could have experienced after its initial impact with the substrate (e.g., essentially no further ***movement*** would be expected with soft soil or sand; however, a casing may continue to bounce several feet or even yards over smooth concrete).

How certain trace evidence, physical damage, or changes to the cartridge casing might have been acquired or have been caused (e.g., an ejection port of a semiautomatic pistol within a few inches of a brick wall at the moment of discharge, leaving abrasive damage on the casing with corresponding red mineral inclusions).

cartridge casings *ejected* over hard surfaces such as asphalt and concrete will usually show weral sznall impactive sites on the case rim and/or case mouth when examined under a ster-eonlicroscope. If the cartridges were fired from a fast-moving vehicle driven over the same type of surface, these "dings" will be numerous. They often eont-airk small amounts of embedded trace evidence characteristic of the surface on which they fell. With a little experience and lest Fixing over the same type of surface, the examiner can come to recognize this "damage" And differentiate it from later post-impact damage such as described in the next section,

Relocated Cartridge Casings

Post-ejection events *must* be considered prior to any interpretation of the location of a recovered cartridge casing. These include being stepped on or run over by vehicles, events that might cause a fired cartridge case to be moved. Fortunately, the generally soft nature of cartridge casings makes them quite susceptible to impact damage, abrasion, and/or deforrea-Eon if stepped on, run over, or kicked. These actions usually (but not always) leave evidence on or in the cartridge case—for example, multiple deep abrasive gouges in the case wail and/or crushing of the case mouth, These marks, once recognized, evaluated., and properly interpreted can indicate whether or not the casing has gone through a norrhal extraction /ejection cycle

These same marks and the trace evidence embedded in them may also provide clues to the type of surface .irt which the cartridge casing fell or surface *against* which it was ejected. The laboratory examiner Imisi study the marking left on fired cartridge casings during the extraction/ejection cycle of the responsible gun. This should be clone using cartridges of the involved brand and toad and after inspecting them to make sure they are free from any manufacturing or other marks that might be confused with marks generated by a firearm.

The isolation and elucidation of other firearm-generated marks, such as magazine lip or latch marks, chamber marks, and/or slide scuff marks, will also be necessary so as not to confuse them with those actually associated with the extraction/ejection cycle. Laboratory familiarity with ejection port clings is also of critical importance because they can crush the mouth of a cartridge casing. These dings are certainly post-firing, but are not the consequence of relocation damage.

Firearm—Ammunition Performance

[n semiautomatics and machine guns, certain requirements of impulse to the bolt or slide followed by adequate impactive forces to the cartridge case from the ejector must be met to Properly extract and eject the case from the gun, These requirements are directly related to the condition of the gun as well as to the performance of the ammunition during discharge, -ate corresponding marks on the casings leave a variety of clues regarding the normal/proper performance of both the ammunition and the gun.

Examples Of marks Deft on casings and other characteristics that indicate whether a casing was fired in a normal manner include cartridge casing expansion. firing pin drag. breech. face impressions, extractor marks, ejector *marks*, chamber marks, and/or ejection port dings. Cartridge casings experiencing abnormally high- or low-pressure excursions in performance during discharge often reflect such events in the markings on the casing and/or the casing's degree of expansion when fired.

Comparison of the various markings on *evidence* cartridge 'casings with those produced on test-fired cartridges of the same brand, type.. and load fired from the same gun permit assessment of which variable or firearm component may be responsible for a particular event under investigation. Varying selected parameters such as bullet weight or powder charge allow one to evaluate the role in or contribution to 'ejection pattern of any particular ammunition parameter of interest to the examiner. Note that this statement is not an invitation for someone inexperienced in ammunition loading to assemble cartridges of unreasonable or uncertain pressures because there can be a high degree of risk associated with such endeavors.

REVIEW OF MARKS ON FIRED CARTRIDGE CASINGS

Figure 14.3 summarizes nearly all of the markings that might happen to a fired cartridge casing. Some of these are or may be generated pricer to discharge, and are included in the

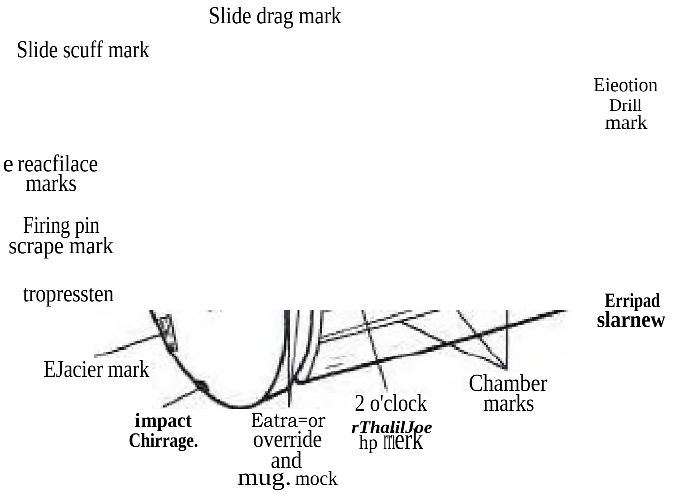


FIGURE 14.1 Marks on fired carbritige cabs.

This figure surnmarim. the variou$ Firearm-induced marks that can be found on 'Earl:ridge uses that have been chambered, Cirpr1r anti cdoetod firma semiautomatic pistol Many of them ii.ocr...Na individuality **and can** be assci. aled with the rmporisible firearm. Other$ have recopstractive value and **allow one to determine how the cartridge came** b be loaded in the firearm (e.g., maritally iftserteil in the chamber or stripped from a magazine atter slide retraction as shown). Any impact damage as a result of ejection over hard surfaces *such* as concrete and asphalt usually takes the form of small clings around **the mouth and** for rim of the cartridge case. Two such areas of impag elamaso fire Shown, These often contain minute partieLm irnLneral material that can be further characterized under a 5uitabie microscope.

general category of *chambering* marks. They may occur while the live cartridges are retained in the magazine of the firearm (e.g., latch marks on the head of a shotgun shell when it becomes the next cartridge to be chambered). They may *occur* as well while the bolt or slide of a semi-automatic pistol is attracted and its underside drags along the length of the top cartridge in the magazine 6,e,, slide drag nark) or when the cartridge is stripped from the magazine (i.e., magazine lip marks). Scuffs on the cartridge case body and/or its head (e.g., a 12 o'clock slide scuff mark) may occur as the breechface impacts the 12 o'clock position of the head of the top cartridge in the magazine, as it is forced up the feed ramp and into the chamber.

Depending on how the gun is designed and how it has been loaded, the extractor may strike the head/rim area of the cartridge casing, ride up and over the rim, then snap down into the extraction groove, leaving *as* many as three marks. A cartridge dropped in the chamber, followed by the release of the slide into the battery, stands the greatest likelihood of creating these types of marks on pistol cartridges. Such a chambering process could be repeated multiple times, creating numerous marks of interest, but *none* the consequence of cartridge casing extraction. If the gun's design calls for the cartridge to slip under and behind the extractor during loading, then the only mark produced by the extractor at this point might be a small nick or gouge in the bottom of the extraction groove or immediately pent to the rim in cartridges lacking an extraction groove.

Finally, during the discharge phase the extractor *may* produce an indentation on the forward-facing side of the rim as it forcibly pulls the cartridge casing from the chamber. This type of mark is particularly likely with locked breech guns as opposed to straight blowback guns. The extractor in a straight blowback design is riot functional because the cartridge casing is literally blown out of the chamber. ..An extractor is present in blowback guns to allow for extraetiori of live cartridges from the chamber during unloading. Chamber markings (or additional chamber markings) may be acquired, particularly in blowback guns, during this phase as the swollen cartridge casing is expelled rearward out of the chamber.

Finally, the head of the cartridge casing is ultimately struck by the ejector, typically causing the casing to pivot around the extractor or simply to be knocked clear of the breechblock. With manually operated guns (e.g., bolt-action or lever-action rifles), an ejector mark may not be visible 5imply because of the greatly reduced force with which cartridge casings typically **strike** the ejector, as compared with semi- or fully automatic firearms. Daring their final exit, the cartridge casings may strike one or more areas around the margin of the election port and acquire additional marks as a consequence.

With **Some** firearms this occurs with great regularity and reproducibility, and leaves an outstanding mark on the body of the cartridge casing or adjacent to its mouth, For these reasons, ejection port dings are often identifiable as having been created by a specific firearm. The fact that the casing is striking areas on the gun during ejection greatly affects the fired cartridge's ejection characteristics. These types of marks typically cannot be created except in an actual firing.

For normally generated marks on cartridges, the examiner should design a testing protocol that will isolate their source and production. This is important for a number of reasons. First, the examiner should be prepared to state whether the fired cartridge appears to have been *rormahy* chambered, fired, extracted„ and ejected. Second, any atypical or foreign marks deserve to be explained since they may be important and may relate to some nonstandard use of the firearm or to some misadventure such as restricted or retarded slide travel.

A situation where this might be important is a purported struggle over a gun. A weak hold with some recoil-operated guns, for example, may reduce the slide travel and rest. in a weak strike by the ejector, with a corresponding reduction in ejection distance and/or direction. This may occur in awkward holds on a pistol with self-inflicted shootings or atti- dental discharges during unsafe handling. A suggested laboratory protocol is as follows;

1. Obtain cartridges of the same brand and type as those involved in the incident. Disassemble an evidence cartridge and one of the reference cartridges to ensure that powder morphology and quantity are in agreement. If available and of sufficient quantity, use evidence ammunition for testing, As an alternative to disassembly, a volley of at least a few shots of both evidence and exemplar ammunition should be fired together to determine if the pattern is affected by the difference.
2. Examine and select cartridges free of any preexisting marks that might later be confused as having been produced during the cycle of loading, firing, extraction, and ejection.
3. To examine magazine lip marks, and if the firearm uses a detachable magazine, load some of these cartridges in the magazine and then, with a nondefacing tool such as a pencil eraser, strip them out of the magazine by pushing against the head at the 12 o'clock position. As each cartridge comes up to the top of the magazine, place a suitable index mark on it so the source and position of any magazine lip marks can be ascertained.
4. To examine chambering marks from the feeding process, chamber a few cartridges using the full-forward force of the slide, but remove them gently from the chamber so that feed ramp marks, slide scuff marks, chamber marks from the loading process, and extractor marks from the initial phase of this process can be isolated. It may be useful to do this by inserting the magazine with the slide locked back, as opposed to retracting the slide over a previously inserted magazine containing cartridges. A slide drag mark can only occur with the latter method. Its presence or absence may be important when intercomparing cartridge cases from a multishot incident.

S. Insert a cartridge in the chamber by hand and close the action to look for any extractor override marks. It may be desirable to vigorously cycle several live cartridges through the gun's action to see if, by this means, a visible ejector mark can be left in the head of a live cartridge. This should be done with the utmost care, with the gun pointed downrange. It is also advisable to keep one's hand clear of the ejection port in case some malfunction or alteration allows the ejector to strike the primer and possibly discharge the cartridge. Alive cartridge, with its projectile and propellant charge, is much heavier and possesses more momentum than a fired cartridge casing. For this reason, live cartridges cycled through guns at shooting scenes may acquire an ejector mark. This may be of value for live cartridges found at a scene or in verifying that an ejector mark in a fired cartridge is indeed the consequence of discharge and not some previous cycling through the gun's mechanism.

6. Obtain test-fired cartridge casings using a normal or firm hold, making provisions to capture them before they impact hard surfaces.
7. Obtain test-fired cartridges with any alternate holds deemed appropriate or germane to the incident under investigation. Capture them in the same manner and compare the markings with the previous cartridges.

If appropriate, obtain test-fired cartridges from semiautomatic pistols with the slide delayed or restricted. This can be accomplished by wrapping multiple rubber bands around the slide and frame. The additional force for slide retraction can be measured with a force gauge,

An often important factor to consider is the number of cartridges that were in the firearm at the time of the shooting. When setting up for a test firing, load the gun to the same load condition as involved in the incident (if known). While this rarely makes a practical difference in how cartridge casings are ejected, it is possible that the amount of pressure exerted op a casing being ejected by cartridges remaining in the magazine will affect the pattern, This is highly dependent on whether the particular mechanism of the gun allows the top cartridge to touch the departing casing, but by testing the firearm in the same condition it was in during the incident, this factor is easily accounted for.

For example, a law enforcement officer's training will typically dictate that his handgun be loaded to the fullest possible condition. Thus, a full-size Smith .gr Wesson NISEP9 *pistol* will be loaded to 17 — 1, meaning seventeen cartridges in the magazine and one in the chamber. However, a shotgun or urban rifle carried in a car or trunk will commonly be in a "cruiser carry" condition, meaning that the chamber is left empty but the magazine is fully loaded. Attention to the loading configuration of an officer's gun is one of the very few saykng graces in investigations of officer-involved shootings (015.$), as compared to invim4tigalions of more "everyday" shootings.

That having been said., we have come across many instances where certain officers are not as conscientious as they should be when carrying a firearm. We have seen underloaded inagazine6, the wrong ammunition, or firearms in poor or inoperable condition. In cases like these, a thorough review of statements, depositions, and scene notes is critical As mentioned in other chapters, proper, thorough photography of involved firearms and note taking at a scene are crucial to a good investigation.

When considering the number *of times* to test-fire a firearm in an ejection pattern test, there is no set standard; however, the investigator should place himself on as firm a statistical footing as possible. Our common role of thumb is to replicate the scenario of the shooting a *ritini/Man* of 10 times. In other words, if the previously mentioned M&P9 shooter started riff with a 17 + 1 load condition, and fired 3 shots in the event, it would be wise to fire the gun from this condition 3 times, then reload to the 17 + 1 condition, This should be repeated another 9 times. fora total of _?.0 shots fired_

Theinvestigator would be wise to remember that, from a statistical standpoint, the number of fired cartridge casings recovered at a scene should have some hearing on his confidence in the firearm.

In the *case* of a stationary shooter, for example, a cluster of 10 fired casings holds more weight in positioning a shooter in a scene than a single fired casing, because the duster allows for an evaluation of the spread, or vneertainty, for that ammunition combination_ A single casing should not hold as much weight, not only because the amount of deviation *for* the gLm— ammo combination cannot be accounted for but also because a single casing is easier to inoNre (by responding officers, medical personnel, *etc.)* than an entire duster. Following this logic, a string of 15 cartridge casings over a span of 60+ feet cannot realistically b€ accounted for by accidental kicking. A scenario such as this is indicative of a shooter in mollicin.

LABORATORY EXAMINATION OF EJECTED CARTRIDGE CASES

Insofar as questions and issues regarding cartridge case location and ejection patterns are concerned, the laboratory examination of fired cartridge cases should include the following:

- Inspection of the interior of the cartridge case for foreign debris (dirt, sand, water spots, spiderwebs, etc.) in order to address the issue of "freshness" or signs of exposure to environmental conditions.
- Inspection and description of the exterior of the cartridge case for adhering foreign debris (dirt, mud, sand, water spots, stains, etc.) arid surface shine versus tarnish.
- Checking for any out of roundness of the case mouth or case body, which might be indicative of post-fire crushing.
- Inspection **for any** abrasive or impactive effects with nonfirearm-related surfaces. (With impacts on concrete and asphalt, the rim and/or the mouth of the cartridge case typically receives one or more rough dings or indentations, often with small particles of embedded mineral material, in these areas).
- Examination of any gouged or striated areas on the case wall that are not firearm-related. (from, say, the case being kicked while resting on a hard surface or being run over by an automobile, either of which tends to leave characteristic damage in this area).
- Assessment of any other form of adhering trace evidence such as paint, plaster, or stucco that might be associated with a surface the cartridge case impacted after discharge.

Documentation of any of these phenomena by sketches and/or photography is important, particularly **in situations where** trace **evidence is seen adhering** to the cartridge case because this evidence can easily be dislodged during subsequent handling and examination.

General Protocol for Ejection Pattern Testing

Test-firing the actual firearm with the same type of ammunition in an open area with a prearranged coordinate system will be necessary. Both circular and Cartesian (rectangular) coordinates have been used for this purpose. We routinely use the Cartesian coordinate system, with the intersection of the x-axis and y-axis directly below the firearm's muzzle or ejection port and the y-axis aligned with the barrel. The use of the muzzle is usually preferable because it is typically the same reference point used in gunshot residue determinations.

Additionally, the cartridge casing locations can be measured to the nearest half foot. Documentation to the nearest inch is unnecessary given the level of accuracy that will be attributed to the final conclusion. Once again, the fact is that a conclusion of firearm/shooter location based on ejection patterning is not going to have the accuracy attributed to trajectory aesessmente.

Multiple metal tape measures are laid out on the surface to form the x/y-axis and to provide a grid for later measurements. The proper positioning of the gun relative to the coordinate system can be accomplished by dropping a plumb line from the trigger guard or other suitable location to the designated spot on the surface. Alternatively, a tripod can be **set** up so that the gun can be held at the appropriate location. A preselected aiming point should be established to achieve the desired vertical angle. For example, if the shooting event is

believed to have involved a 45-degree downward shot or shots, an aim point that yields a downward 45-degree barrel angle should be employed.

For most shooting events, an aim point yielding a horizontal (D-degree) barrel angle would be used. Gun height or the shooter's position (prone, kneeling, or standing), gun rotation, and possibly even the nature of the hold on the gun may need to be considered and varied to properly evaluate the implications of cartridge casing location(s) at a shooting scene. Once again., it is important to realize that given the accuracy of ejection patterning, differences in results from variables typirally come from drastic, not subtle, changes in setup.

The further study described here could be used as an experimental model for case evaluation. Several firearms were chosen based on their relatively unique ejection characteristics. Glock 27 was chosen as a classic example of right and rear ejection. An '08 Luger was chosen for its 12 o'clock extractor and 6 o'clock ejector. (This configuration typically sends fired cartridge casings up and directly over a shooter's head.) A Walther P38 was introduced because the ejection pattern is reversed from the classical pattern: The ejector and extractor are on opposite sides from 'normal.," a configuration that disperses cartridge casings to the left of the gun under typical circumstances,

Test firings were conducted in five pitch variations. Straight downward (-90 degrees; Figure 14.4(a)), downward at a -45-degree angle (Figure 14.4(b)), horizontally (normal orientation; Figure 14.4(c)), and directly upward (+90 degrees.: (Figure 14,4(d)). Figures 14.4(e), (I), and (g) show results of the tests, including one at an upward, 45-degree angle. A forklift was employed to allow the shooter's legs a degree of safety for the downward shots and to hold a Kevlar-filled capture box for the upward shots.

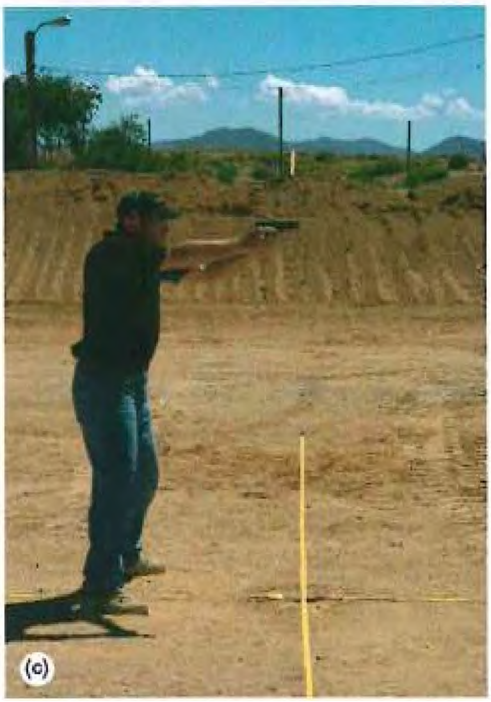
The overall lesson to be learned from the evaluation of these data is that the most expected result of a tipped-down muzzle is the more forward ejection of cartridge casings. Conversely, a significant rise of the muzzle tends to bring the pattern back toward the feet of the shooter.

The nature and behavior of the surface on which the evidence cartridge casing(s) falls is yet another consideration, A cartridge casing falling on smooth sand will remain at its initial impact site, but the same casing landing on concrete will seldom, if ever, do so. The cylindrical shape of cartridge casings, their displaced centers of gravity, and their propensity to rebound from hard surfaces—all of these factors, with most surfaces, combine to send the casings off from the initial impact site in various directions.

The fired cartridge casings themselves emerge from the ejection port of the gun with a tumbling motion, and at departure angles and velocities that can vary slightly from shot to shot. The net effect is that a series of fired cartridge casings will land in an area. but not a fixed spot The size, shape, and location of this area become the subject of ejection pattern testing.

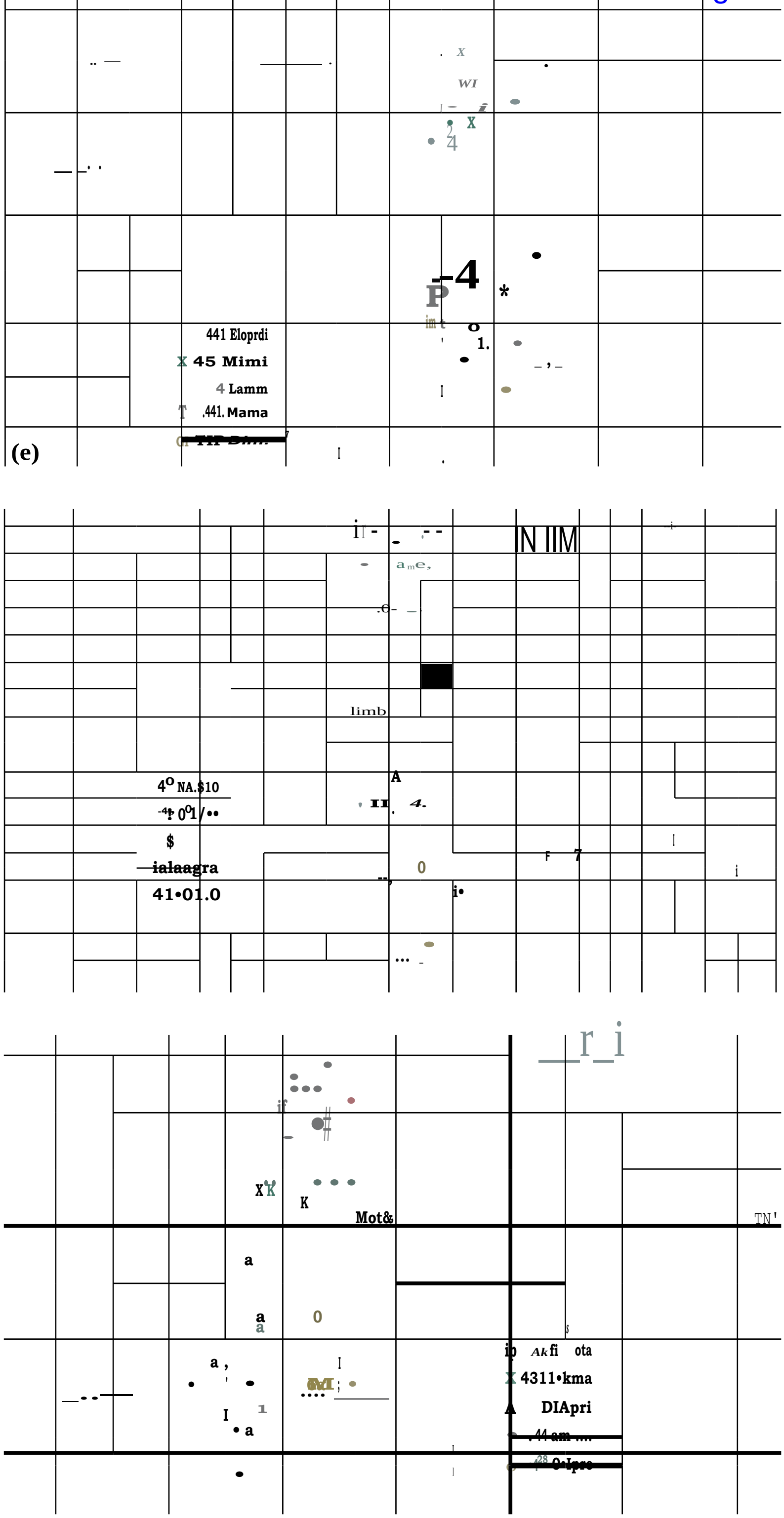
The reproducibility of the ejection pattern for a particular gun-wirrtunition combination is illustrated in Figure 14.5, an aerial view for three consecutive cartridge casing ejection patterns for a 9mm Model 92F Beretta pistol fired over a nonresilient surface (uncut grass). Note the height change for Group 3 and its minimal effect on ejection pattern for this particular gun-ammunition combination.

Figure 14.6 shows a more complicated pattern for a .40 S&W pistol fired over level asphalt. The dashed lines represent the path from the initial impact point with the asphalt *(diamonds)* t their final resting positions *(circles).* In most investigations the final position of rest is the



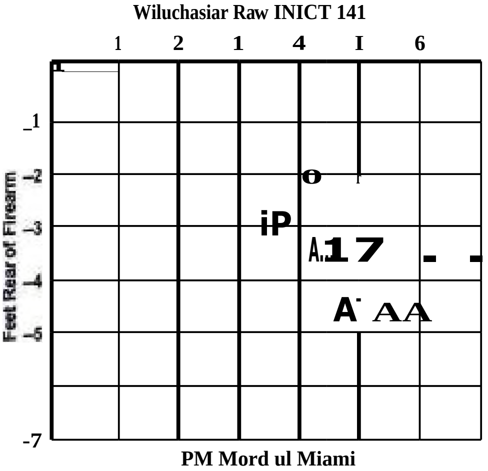
FiatI la. 1 4.4 (a} With the firearm %131 **over the** if y-axis, **a downward angle of 90 degrees is attained- di) Downward angle of 45 degrees while the** firearm is oriented 211.' r **the sly-axis. (c) Shooting under "normal" conditions.**

FIGURE 14.4 (d) As viewed along the y-axis, test firing with the firearm in a +90-degreestraight-up) orientation.



(e)

Ejection pattern resulting in various Oricrandons fora Clock 27. (f) Ejection patter,, resulting in various orientations for an '08 Luger. (g) Ejection pattern resulting in vari0u_9. orieniations for a Walther P38.



FIG". 711.E 14,5 Reproducibility of a cartridge ease **ejection** pattern.

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this plan view stow three Oen.SeCutive cartridge **case electiCrn** patella% for a `grim Senate. pistol bred over a nort-milk:Tit surface (uncut grass). The gun position is *at* the D/O-a..16.5 intemept point, with the arrow Inclicaiing the diroci on firo. Note the 12rshi **change tar Croup 3 and itg relnixnal of act ort** ***the Elocgort patiern for this*** **parideLliar gun-arctritunition** combinatir n.

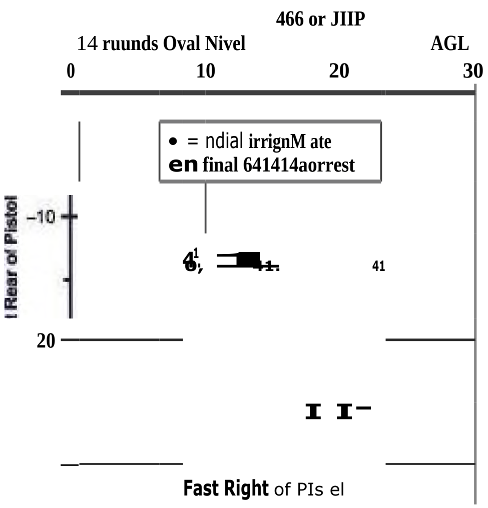


FIGURE 14.6 Cartridge case ejection pattern over a **hard** surface.

This diagram shows the pattern for **a AO MeW 00°1 fired over level asphalt and the effect of impact with a hard ³.1111 sorraewhat uneven surface. Tile Fan pOsitOn is** at the 0/0-axis intercept point. MI Of the fired OrtridgeS were **ejected** to the **right arid** rear **of the csian1 when fired in the normal configuration** and with **the barrel parallel to the ULMNAO. The elecht4el rarameartt the path Item th4 initial impact point with the suphaLF *(thalilerthd2) to* iho Final Pogborm Of Mit (rireix6).**

pattern in which we are interested, but a study of this type is useful to appreciate and understand post-impact behavior,

An assistant will be needed in such a shady to promptly identify and mark the initial impact site after each shot, 'This must be followed by a means of associating the particular cartridge casing with the specific impact site, The assistant can also provide information on the typical heights (if any) to which the ejected cartridge casings rise above the level of the gun. This can be important if there is the possibility or question of a fired cartridge casing passing over a fence or the roof of a car before landing on the ground.

Setting up a video camera at the same height of the gun, and at *an* appropriate position and distance behind it, can be useful in several ways. When properly positioned, the camera can record the flight characteristics as well as the behavior of the cartridges after ground impact. If photography of the final pattern of ejected cartridge casings is contemplated, the casings' positions should be identified with suitable markers. Once the markers are in place, at least one photograph should be taken from behind the pattern, with the shooting position in the field of view, and another should be taken with a profile view of the pattern and shooting positiom (See Figures 14.7(a) and (O.)

Fig-ure 14.8 (page 260) shows the effect of pointing the particular test firearm downward at a 45-degree angle compared to the same pistol fired parallel to the terrain. The general ejection characteristics of most semiautomatic pistols are either right or right and teat In these situations, when such a pistol is pointed down, the rearward component is shortened with the result that the fired cartridge casings impact the surface further and further forward as the downward angle is steepened.

Additional study of how pitch (up and down) variations affect ejection patterning can be carried out with several types of firearms,

Cartridge Casings Ejmtcd from Moving Vehicles and/or Firearms.

Tice behavior of various cartridge casings ejected from moving vehicles traveling over common asphalt at speeds ranging from 10 to 40 mph was studied. As one might expect, the increasing speed of the vehicle increases the scatter of the casings and continues to move their final resting place further and further away from the launch or ejection point in the direction of the vehicle's travel.

Microscopic examination of the brass cartridge casings showed increasing damage with increasing vehicle speed in the form of multiple clings. Increased vehicle speed also corresponded to an increasing number of sites of embedded mineral material from repeated impacts with exposed stones in the asphaltic concrete, This impact damage wieldy exceeded what was found with an ejection over the same surface from a stationary position.

With adequate testing it may be possible to set some limits on the speed of moving vehicles from which shots are known to have been fired based on the distribution of the fired cartridge casings relative to the trajectories of the shots and the damage the casings have sustained.

Movement of the firearm itself can cause a difference in the final rest locations of cartridge casings. This may be encountered when a shooter thrusts a gun forward or pulls it rearward during the firing cycle. As an examples a Walther PPK, .38(1 Automatic pistol was fired in a stationary, normal orientation and then fired repeatedly under two "in motion" scenarios, The first was a simple thrust-forward action; the second, a strong forward thrust-

FIGURE 1¢-i Photographs of two cartridge case ejection patterns that allow one to better visualize them.

(a) **ThiS. photograph at4w6 a profile via'W of the pattern for a 9 nun pLstol fired over level &mund (coarse sand). Nunibered markens have bean placed over 42actof the Fired cartridge uises. The tape measures provide a coordinate system and a means of measuring the position of each cartridge case relative to the point immediately below the pinkora eieefithill port. The tripod is used as a tafersiAre poink for the positioning and repositioning of the gun for each shot. The shooter's hands are hardy touching the !cop of the tripod as each shot is fired. A plumb bob and line of a selected length suspended front the shooting hand and oriented over the .0/0-axis point can also be used for this purpose.**
This photograph shows the same pattern with the camera positioned in front of and slightly to lie right of the 5hcoter. The numbered markers for these 10 shots have been turned to face the camera. A view from behind the gun and shooter accomplishes the same encl.

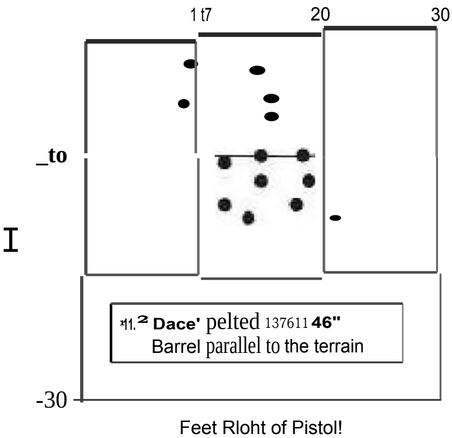


FIGURE 1.4.8 Cartridge case ejection pattern: The effect of vertical angle changes for a .40-caliber Clock fired over coarse, level sand with Winchester 180-gr JEEP ammunition_

This pistol **was** find 10 times with a conventional grasp and with the barrel 48 inches above and parallel to the terrain. An additional 10 rounds were discharged with the pistol pointed down at a 45-degree angle arid a height *above* ground level of 32 inches. These results are typical for mast right-rear *dins guns in that a downward shooting angle moves the pattern of ejected cartridge cases forward.

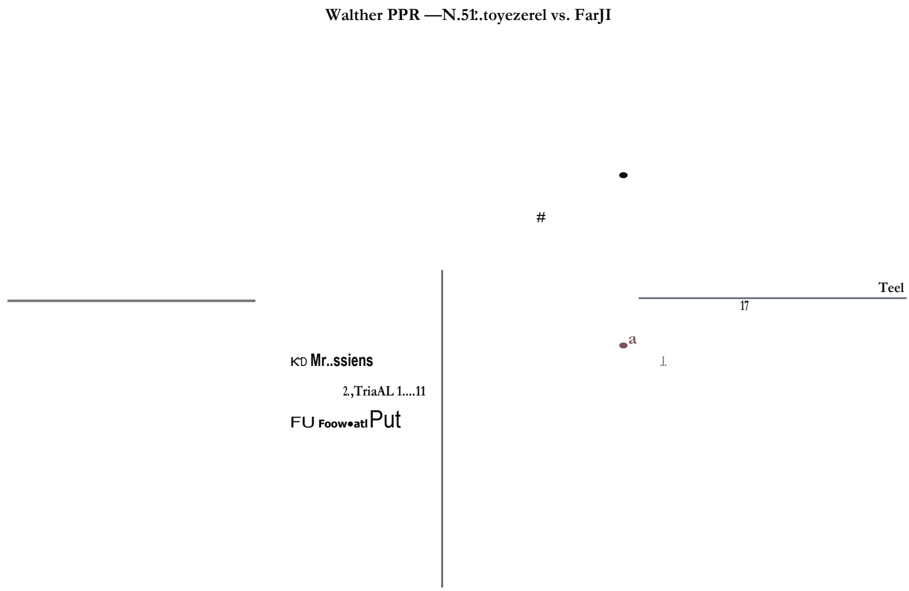
As shown in Figure 14.9, the forward motion of the gun was imparted to the casings., which traveled between 2 and 10 feet further forward than they otherwise would have under normal circumstances.

Additional Considerations

To cycle properly, recoil-operated guns need to be held with a reasonably firm grasp. During the discharge process, the slide and barrel recoil and move rearward together for a short distance, and subsequently unlock while the frame is secured in the shooter's hand or hands. A poor or loose grip on some recoil-operated pistols can affect the extraction and ejection process to the point of causing a stoppage or jam. **A** very loose grip can altogether prevent the casing from being extracted from the chamber in some pistols. Although it might *seem* unlikely that anyone would hold and fire a gun with such a hold, it may be necessary to evaluate this potential variable in certain cases.

In some semiautomatic firearms the position and/or force exerted on the extracted cartridge case by the top cartridge in the magazine can have an effect on the subsequent ejection. This can often be seen in AK-47- and SKS-type firearms. The cartridges in these magazines are staggered so that the top cartridge is alternating between left and right The result may be seen in alternating paths of the ejected cartridges.

Likewise, the force acting on the top cartridge in the magazine may play a role in the ejection of a fired cartridge. When a magazine is nearly full, the upward force on the top cartridge is much greater than on the last cartridge. This may have an effect on the ejection of the fired cartridge, which can easily be evaluated during test firing. The easier approach is to design the ejection pattern tests around the facts of the case. If the shooter is known to have fired four shots starting with a fully loaded magazine, then conduct the ejection tests in the same manner.



f IGURE 14.9 Comparison of eectectcartridge casing locations in stationary versus. "in TriOtiors" scenarios.

Whether or not the firearm was canted can be another issue. Largely as a result of movies, the rotation of a firearm **either right** or left **has become** a popular cross-examination question at trial, In **general,** if **a normally right-ejecting pistol is rotated 90 degrees to the lea,** pointing the ejection port skyward, casings will tend to travel upward **and to the pistol's left. Rotating the pistol to the right, pointing** the ejection port to **the ground., will tend to** leave casings **almost at the shooter's feet.**

Proper training in gun handling and shooting position requires the grip to be in a vertical orientation for proper sight alignment. However, just because it **in improper to cant a** firearm **to the right or to the left does not** prevent a shooter from doing so. **If this issue is raised** and is deemed to be of concern, then it too must be added to the **list** of variables to evaluate **in any ejection pattern testing. If the shooter is cooperative, the question of** canting needs to be put to him or her in a neutral fashion, Interview questions such **as**

- **Could** you please demonstrate your best twonection of heo/ you were holding the pistol **when you fired? [Photograph this position.]**
- Could you demonstrate how you believe you were standing **at the moment you fired?**
- **What is the** highest you believe you could have been holding the gun at the time of **the shot** and tf▶e lowest? [Get measurements of the height of the gun above the surface.]
- **How were you trained to hold and shoot this pistol?**

There are, no doubt, additional questions **that deserve to be asked of the shooter depending on** the facts and possible issues in the particular case, **but these can serve as a starting point.**

MANUALLY OPERATED FIREARMS

The techniques described in this chapter are *not* necessarily applicable to mechanically operated firearms **Buch** as bolt-action and lever-action rifles, revolvers, pump/break-open shotguns, and single-shot pistols, With these and similar firearms, the location of the fired cartridge casing only provides some insight into where the shooter removed it from the gun. This location may or may not relate to the shooting position.

SUMMARY AND CONCLUDING COMMENTS

It must be said that of all the matters investigated and evaluated in shooting incidents, the interpretation of cartridge casing location and ejection is fraught with the greatest uncertainty. This is meant as a strong word of caution and not as a statement of futility. Despite the numerous variables, and recognizing **that** some of these are beyond our ability to know, we can often state with reasonable certainty where the semiautomatic pistol, rifle, or shotgun was not fired. The same holds true for fully automatic firearms. This is in keeping with the approach employed in the *scientific method—that is,* ruling out certain hypotheses. Consider the following:

- A cartridge casing can only be ejected so far by the gun that fired it.
- The design of the particular gun sets limits on the direction in **which** the fired cartridge case must emerge from it.
- While it is true that the performance of the ammunition may play a significant role in the extraction and ejection of fired cartridge casings, commercial ammunition is typically a highly refined and consistent product.

Subsequent laboratory inspection of evidence and test-fired cartridge casings can provide considerable information about the actual performance of the evidence cartridges during discharge, extraction, and ejection.

With semiautomatic and fully automatic firearms, cartridge casing location, as an expression of khe shooter's approximate location, can be important in evaluating various accounts and theories related to a shooting incident. The *accuracy* of such determinations increases with *an increase* in the number of shots fired and/or trajectory information as a consequence of perforating bullet strikes to relatively fixed objects at the scene,

For example, two compact groups of pristine, undamaged cartridge casings, all fired by the *same* semiautomatic pistol, at two very different Locations indicate a change in the shooter's position. If some of these shots have struck and perforated fixed objects., such as a wooden *fence* and then *a* nearby building wall, considerable improvement in establishing the shooter's location will be realized by integrating the trajectory information with a cartridge casing ejection pattern.

Trace evidence adhering to, or embedded in, recovered cartridge casings can provide very useful, and sometimes critical, information irk certain instances, yet it is often overlooked.

Shots fired from moving vehicles may have special value or importance. With sufficient testing over the same, or comparable, surface, reasonable inferences as to the speed of a vehicle from which one or more shots are believed to have been fired can be drawn from the

location of the cartridge casings and the degree of impact damage they sustained prior to coming to rest Trajectory information from the scene, if available, will greatly enhance the accuracy of such an evaluation.

Post-shooting incident damage to expended cartridge casings as a result of being stepped on or run over by vehicles is usually apparent and distinguishable from the small sites of abrasive damage around the rim or case mouth acquired by impact with hard surfaces such as concrete or asphalt

Markings on cartridge casings produced by the firearm and/or the shooter's loading practices may allow the *fern* shot to be discriminated from subsequent shots. This would be very significant in a situation where the fired cartridge casings showed obvious movement by the shooter (e.g,, either advancing or retreating as he fired).

CHAPTER KNOWLEDGE

- **a Only** a *few* types of firearm mechanisms were addressed in this chapter- How **many** other mechanisms can you think ol, and how would they affect the meaning of an ejection pattern at a shooting incident scene?
- What steps can you, or would you, take while investigating a shooting incident to make sure **trace** evidence on a fired cartridge casing is pras‘n-ved properly?
- in scientific investigation, the concepts of reproducibility and certainty are common. If a 6k.00k-**ins incident involved a !cilia of 10 Shots fired fitisn a particular gun** in one location, how many test shots would you fire in your election pattern testing? Can you defend this number statistically or empirically?

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SHOOTING INCIDENT RECONSTRUCTION

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Academic Press is an imprint of Elsevier

Academic Press is an imprint of Elsevier
525 B Strcct, Suite 1800, San Diego CA 92101, USA
The Boulevard, Langford Lane, Kidlington, Oxford, OX3 1GB, UK

First edition 2006 Elsevier Inc.

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Library of Congress Cataloging-in-Publication Data
Haag, M. G.
Shooting incident reconstruction / Michael G. Haag and Lucien C. Haag. — 2nd ed.
p. em.
Lucien Haag is the first named author of the earlier ed.
Includes bibliographical references and index.
ISBN 978-0-12.362241-3 (alk. paper)
1. Forensic ballistics. I, Haag, Lucien C. II. Title.
HV8077.H22 2011
363,2562--c1c22 2011005208

British library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

For information on all Academic Press publications
visit our Web site at wwwelsevierdirect.com

Printed and bound by CPI Group (UK) Ltd, Croydon, CR0 4YY
Transferred to Digital Printing, 2013